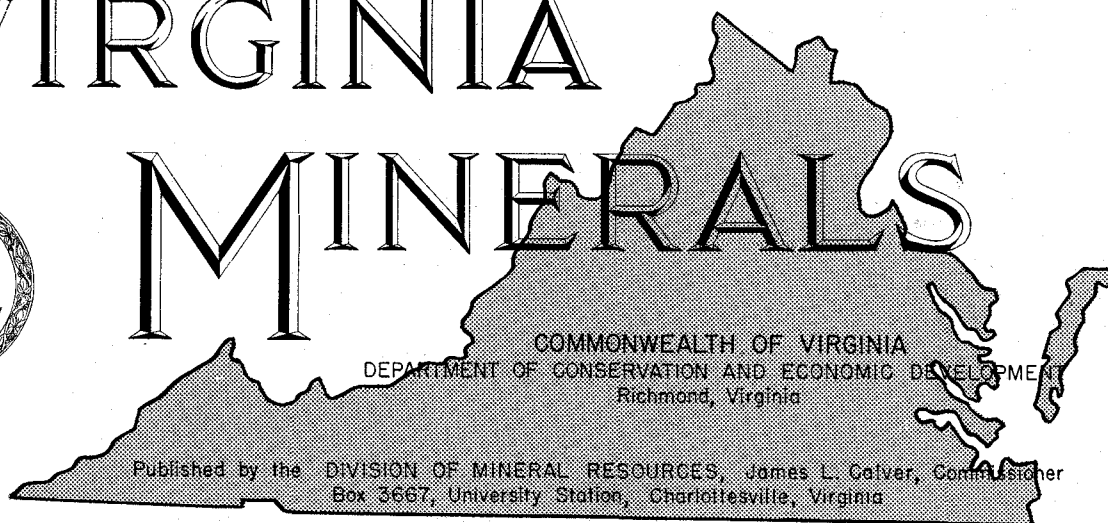


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NATURAL BRIDGE AND VICINITY

Edgar W. Spencer¹

Natural Bridge, a scenic attraction that has long been famous in Virginia, is located in southwestern Rockbridge County in the west-central part of the State (Figure 1). It may be reached by U. S. Highway 11 and Interstate Highway 81, approximately half way between Lexington and Buchanan, by State Highway 130 from Glasgow, and by State Road 781 from the Blue Ridge Parkway.

Several noteworthy studies of the geology of the area have been made. Of these the most comprehensive is the work of H. P. Woodward (1936a), who mapped the Natural Bridge quadrangle (15 minute series). Most students of Virginia geology will be familiar with the classic work of Charles Butts (1940), "Geology of the Appalachian Valley in Virginia," which includes rock-unit descriptions, measured sections, and discussions of the physiography, structure, and resources of the Natural Bridge area. A more recent study by Edmundson (1958) on industrial limestones and dolomites includes several measured sections in the area.

The area around Natural Bridge includes portions of the Blue Ridge, and Valley and Ridge physiographic provinces. The James River flows northeastward across the area. Along its valley at the base of the Blue Ridge there is a prominent 1400-foot scarp produced by the resistant rock units that make up the west flanks of the Blue Ridge. The James River is at an approximate elevation of 740 feet above sea level near Natural Bridge Station, and the peaks of nearby Mill Mountain stand at 1600 to 2200 feet.

From near the crest of Mill Mountain in the Blue Ridge portion of the area a number of small streams flow northwestward following short, relatively straight courses to the James River. Two of the larger streams, Sprouts Run and Back Run, have a dendritic drainage pattern and each is several miles long. They flow across the trend of the mountain front and have valleys over 700 feet deep. Back Run follows a sinuous course even where it cuts across Mill Mountain. The James River has a narrow flood plain in this area. It is less than 0.75 mile wide at its widest point, near the mouth of Gilmore Hollow approximately 2 miles southwest of Gilmore Mills. Where the major streams flow southeastward into the James River, they are entrenched. This is true of Cedar Creek, which flows beneath Natural Bridge, and Roaring Run. These streams are deeply entrenched for distances of 1 or more miles away from the river.

Natural Bridge (Figure 2) is located where U. S. Highway 11 crosses Cedar Creek. The bridge is composed of massively bedded dolomite and dark-blue limestone of the Chepultepec Formation.

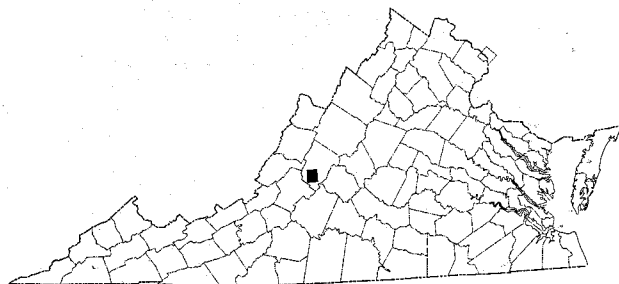
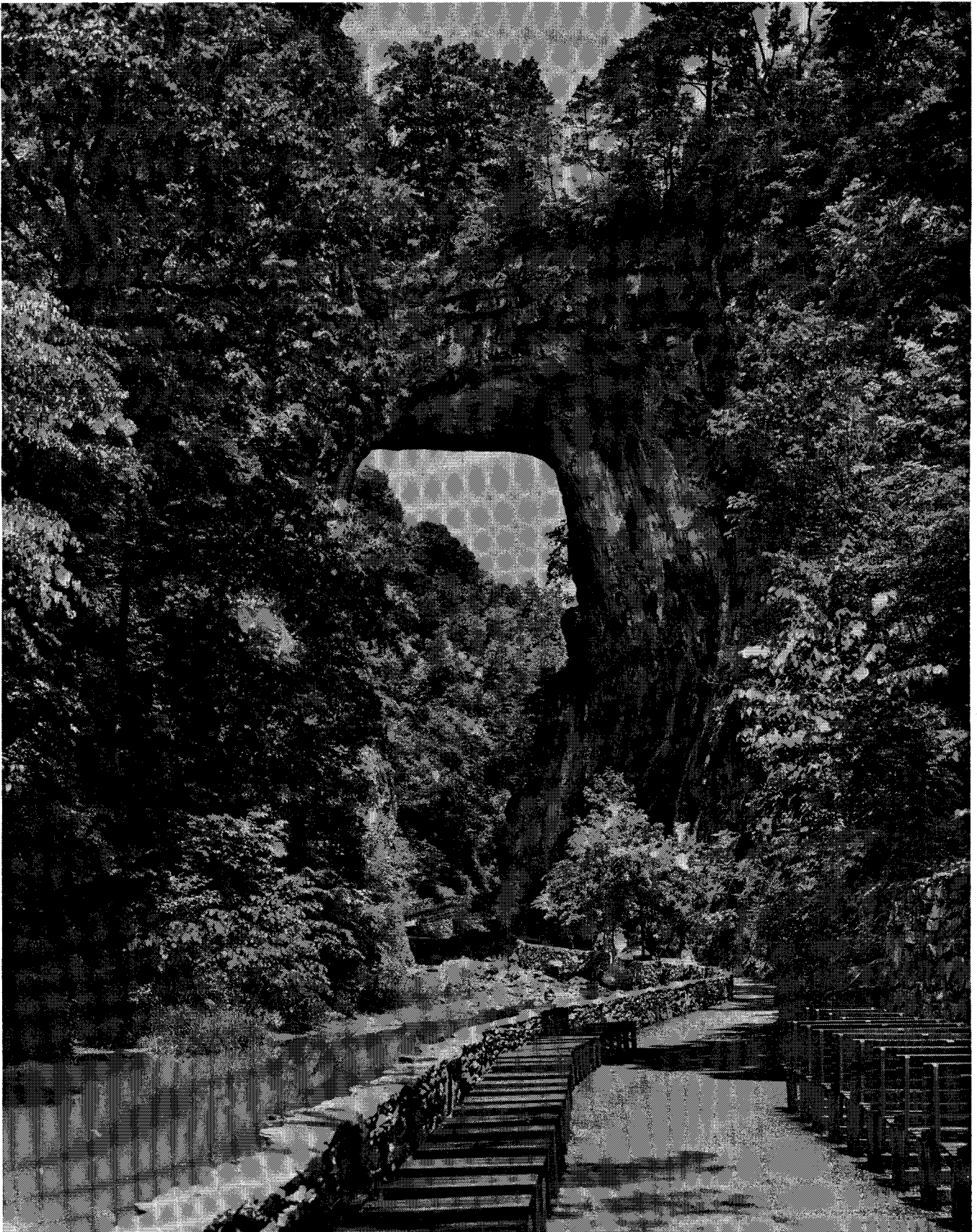


Figure 1. Index map showing location of Natural Bridge.

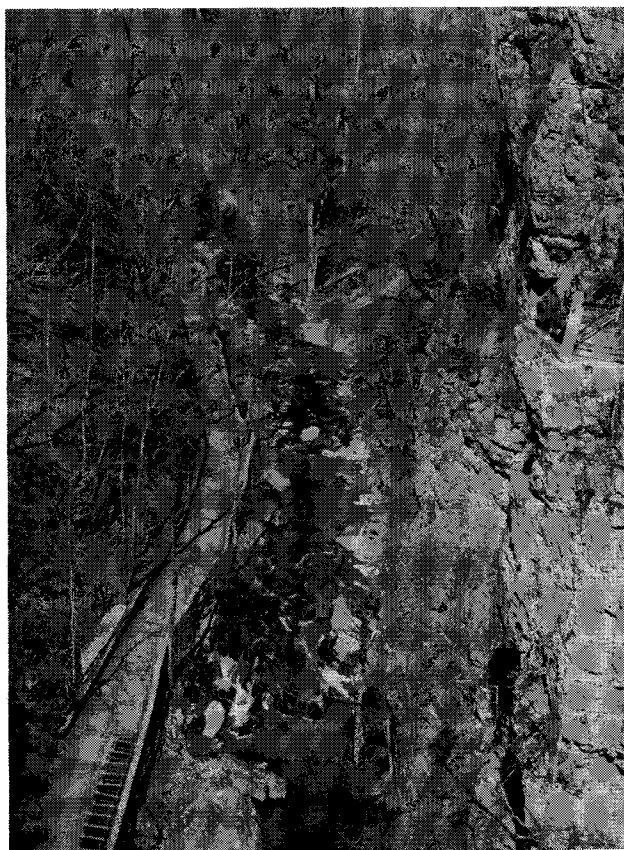
¹ Head of the Department of Geology, Washington and Lee University, Lexington, Virginia.



Photograph courtesy of the Virginia State Chamber of Commerce

Figure 2. Natural Bridge.

The arch is about 45 feet thick at the thinnest point, ranges in width from approximately 50 to 150 feet, and is about 90 feet long. The top of the arch is approximately 190 feet above Cedar Creek. Cedar Creek is entrenched along this portion of its course (Figure 3); it is entrenched from its mouth at the James River near Gilmore Mills to Red Mills, a distance of about 4 miles (Figure 6, see p. 4). Upstream from Red Mills



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Figure 3. View of Cedar Creek from the top of Natural Bridge. Cedar Creek is entrenched along this portion of its course.

the main stream and its tributaries flow in broad open valleys. Two of these tributaries enter Cedar Creek near Red Mills; they occupy northeast-southwest trending valleys on either side of the main stream that extends to the northwest where it heads in the synclinal valley at the top of Short Hills. It should be pointed out that the valleys of these two tributaries are in line with the valley of Poague Run (Figure 6) that flows northeastward near Interstate Highway 81. Several recent investigators of the drainage have suggested that the upper portion of Cedar Creek was at one time a part of Poague Run. The bridge is situated on the east side of Mars Hill. Cedar Creek is entrenched at a level well below the valley of Cas-



H. P. Woodward

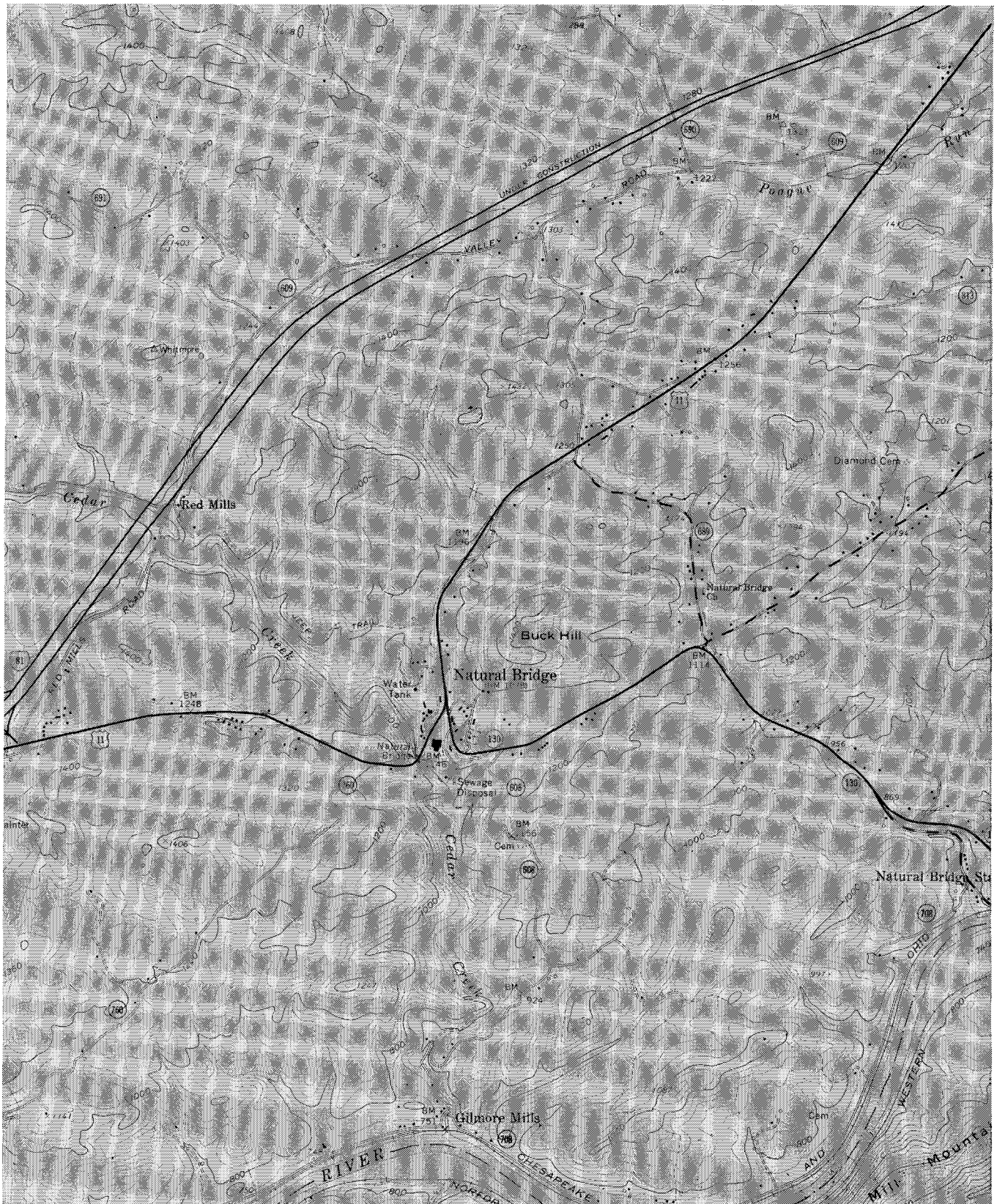
Figure 4. Cascade Creek near its junction with Cedar Creek just southeast of Natural Bridge.

cade Creek in which U. S. Highway 11 is located. Cascade Creek drops rapidly from the main portion of its valley in a series of cascades and waterfalls into Cedar Creek just below Natural Bridge (Figure 4).

The rock units in the vicinity of the bridge are nearly horizontal; they are situated in the trough of a syncline that is broad and open at this point. About 100 yards west of the bridge along U. S. Highway 11 the units are folded sharply, becoming vertical (Figure 5) and then overturned. All of the rock units are fractured, and there are a number of small faults.

In making interpretations in geology, particularly with reference to the mode of origin of natural features such as Natural Bridge, two factors are of importance. First of these is an understanding of the way natural processes function. This understanding has grown considerably through the years since Natural Bridge was first surveyed. The second is the accumulation of factual information concerning the feature. A number of hypotheses have been offered at different times in the past to explain the formation of Natural Bridge, and it is likely that new interpretations will be presented in the future.

Thomas Jefferson (1785) was the first to publish a description of the bridge. He considered



SCALE

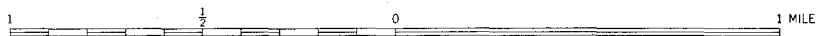


Figure 6. Topographic map of Natural Bridge and vicinity.



E. W. Spencer

Figure 5. Vertical strata about 100 yards west of Natural Bridge along U. S. Highway 11.

that it had been formed as a result of some catastrophic event when he wrote that the bridge was "cloven through its length by some great convulsion." Dr. F. W. Gilmer (1818) was the first to base his ideas concerning origin of the bridge on presently acceptable geologic principles. Gilmer noted that the rock of which the bridge is made is calcareous in nature and that calcareous rocks are soluble in water. He observed that the limestones and dolomites of this region are fractured and that in many places these fissures have been enlarged by the action of water, both near the surface and underground. He suggested that the waters of Cedar Creek were diverted along fractures from the surface of the ground to an underground passageway, creating a natural tunnel which was then enlarged and gradually modified until only the present bridge was left.

C. A. Ashburner (1884) was the first to describe the structural attitude of the rocks as being synclinal and nearly horizontal in the immediate vicinity of the bridge. He concluded that the bridge is a remnant of the top of a cave and that it is located near the center of a gently dipping syncline which accounted for the roof of the cave being preserved at this point.

C. D. Walcott (1893, p. 60-61) suggested that another process was involved in the formation of the bridge:

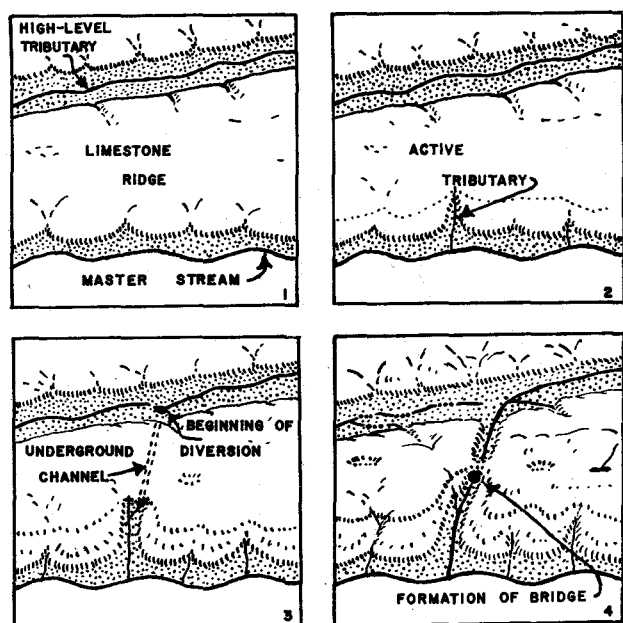
"Cedar Creek was engaged for a considerable period in excavating the gorge from James River to a point not far below the present site of the bridge, where a fall appears to have existed, the summit of which was not far if at all below the present level of the top of the bridge. About this time the water found a subterranean passage in the limestone further up the stream than the present site of the bridge, and through this it flowed and discharged beneath the brink of the falls. The passage gradually enlarged until all the waters of the creek passed through it and the bridge began its existence. What the length of this subterranean passage was is a matter of conjecture; it may have been one hundred or several hundred feet. All of its roof has disappeared except the narrow span of the bridge, and the abutting walls have been worn back by erosion until the gorge or canyon is much wider than at the bridge."

Thus Walcott felt that the bridge formed through the collapse of a short tunnel that resulted from the underground diversion of Cedar Creek upstream from a waterfall. It should be noted that the existence of the waterfall was thought to result from regional uplift which caused a lowering of base level of erosion and entrenchment of the major streams. The waterfall represented a "nick point" along Cedar Creek formed as a result of this entrenchment.

In 1930 C. A. Malott and R. R. Shrock advanced still another hypothesis. They considered that a derangement of surface drainage in the vicinity of the bridge was important. There is a sharp bend in Cedar Creek about 0.25 mile upstream from the bridge. This bend is directly opposite a gap in the east wall of the canyon in which Cedar Creek now flows. They suggested that Cedar Creek formerly flowed through this gap and to the east around the present gorge and the site of the bridge. The present course was established when ground water seeping along the nearly flat strata eroded a cave or underground passageway from the bend to a point just south of the bridge. Eventually the entire stream was diverted to this underground passage. Afterwards a tunnel was formed which was gradually diminished by erosion to its present narrow remnant, the bridge.

H. P. Woodward (1936b) and F. J. Wright (1934) advanced very similar theories, and point to the following additional evidence: (1) The gap that Malott and Shrock suggested was the former channel of Cedar Creek before it was diverted to its present course does not contain river gravels. (2) The bridge is situated on the side of a former valley and not near the floor of any such valley; thus the idea that streams flowed over the bridge seems unlikely. They advance the idea that Natural Bridge is the remnant of the roof of an underground channel through which the waters of the upper portion of Poague Run were diverted into

Cascade Creek, thereby forming present Cedar Creek. The addition of these waters to the volume of the creek enabled it to more deeply incise its course, while the roof of the former conduit largely disintegrated and collapsed through erosion and weathering. Little by little the obvious elements of the underground channel disappeared until, at the present time, only the span of Natural Bridge preserves a portion of the original roof. Figure 7 is a schematic diagram illustrating the progressive development of a natural bridge.



After H. P. Woodward (1936b, p. 615)

Figure 7. Stages in the development of a natural bridge.

Prior to the formation of the bridge, the upper portion of modern-day Cedar Creek was carried by Poague Run to the northeast parallel to the regional strike of the rock units. The lower portion of modern Cedar Creek was then part of Cascade Creek, presently a small tributary to Cedar Creek which enters just below the bridge. Cascade Creek flowed down a steep slope, and because of its high gradient it was able to erode rapidly in a headward direction. Eventually the head of Cascade Creek was close to the course of Poague Run, and its valley was much more deeply incised. At this time diversion of water from Poague Run through an underground passage started. This diversion was aided by the southeasterly regional dip of the strata, the existence of fractures in the limestones and dolomites, and the difference in the degree of entrenchment of the two major streams. These underground waters emerged into the valley of Cascade Creek near the vicinity of the bridge. Because the roof of this tunnel was thicker in a downstream direction, it

was stronger and has resisted erosion and collapse; and that portion of the roof remains as the present-day Natural Bridge.

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Gas and Oil Production in 1963

Natural gas production in Virginia during 1963 totaled 2,084,946,000 cubic feet according to figures supplied by Mr. O. W. Lineberg, State Oil and Gas Inspector, Division of Mines and Quarries. Of the total, 1,479,776,000 cubic feet were produced in Buchanan County and 605,170,000 cubic feet in Dickenson County. Gas from Buchanan County was delivered to pipelines of the Hope Natural Gas Company and the United Fuel Gas Company. Gas from Dickenson County was delivered to lines of the Kentucky-West Virginia Gas Company. Production of oil from the Rose Hill field in Lee County, was 3466 barrels in 1963.

Well Report—Scott County

The Tidewater-Wolf's Head No. 1 E. D. Smith well in Scott County has been abandoned at a total depth of 7222 feet in the Sequatchie Forma-

tion of Ordovician age. The well is located on the Early Grove anticline approximately 6450 feet south of latitude 36°40'N. and 4650 feet east of longitude 82°20'W. Ground level elevation of the well is 1456.3 feet. Shows of gas were encountered in the Little Valley section of Mississippian age. Continuous dipmeter surveys indicated several faults in the well. Formation tops were reported by the operator as follows:

Mississippian

Gasper Limestone	surface formation
Ste. Genevieve Limestone	813'
St. Louis Limestone	2325'
Little Valley Limestone	2596'
Maccrady shale	3502'
Price Formation	3562'
Price sandstone	3760'

Devonian

Chattanooga Shale	4528'
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Silurian

Rockwood (Clinton) Formation	6696'
Clinch Sandstone	6905'

Ordovician

Sequatchie Formation	7184'
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The following cores were taken:

Core No. 1—(Little Valley Limestone—stray sands) 3243.5-3252.5 feet—Recovered 4 feet: wet, bleeding gas.

Core No. 2—(Clinch Sandstone) 6991-6998 feet—Recovered 6 feet: hard and tight.

Logs and other data for the well have been placed on open file at the Division's office in Charlottesville under repository number W-951. A set of 725 samples representing the interval between 19 feet and 7220 feet is on open file.

The Early Grove anticline trends in a northeasterly direction across the common boundary of Scott and Washington counties. The first commercial gas discovery in Virginia was made on this anticline in 1931 by the Davis Elkins interests. The gas occurred in sandy zones in the Little Valley Limestone. Between 1932 and 1947 six other wells were drilled in the field. Beginning in 1938 gas from the field was transported by a 4-inch pipeline for use in the city of Bristol. Production declined in later years and the field no longer produces gas for commercial use.

News Notes

The Economy Cast Stone Company opened a quarry in vein quartz during December 1963 near Free Union, Albemarle County. The quartz is shipped to the company's plant in Richmond where it is crushed. The stone is used as exposed aggregate for building purposes.

The Interstate Stone Corporation is operating a quarry in limestone 6 miles northeast of Harrisonburg, Rockingham County. The company is utilizing a portable plant to produce crushed stone for use in construction of the Interstate Highway System.

W. M. Rice and Son, F. L. Davis, and the Williams Paving Company, Inc. are operating pits in the City of Hampton for the production of fill sand.

Two firms ceased production of aplite in the Piney River area during 1963. Buffalo Mines, Inc. closed its Nelson County quarry, and the Dominion Minerals Division of Riverton Lime and Stone Company closed its quarry in Amherst County. These companies formerly processed the rock to recover feldspar for use by the glass and ceramic industries, in roofing granules, and as road aggregate.

Cuprite from Albemarle County

Stanley S. Johnson

Cuprite (Cu_2O) crystals occur at several places in Virginia, and recently were reported from Albemarle County (Mitchell and Bland, "Rocks and Minerals," Nov.-Dec., 1963). Additional information regarding these crystals of cuprite may be of interest. They were found by the writer while examining gossan ore from the Stoney Point copper mine, approximately 1 mile east of Stoney Point, Virginia. Cuprite, produced by alteration of copper-bearing rocks, is restricted to a zone of oxidation. Randomly oriented cuprite crystals are present in small fractures and in cellular structures of the limonitic gossan. Crystals occur individually and as groups, and are in the form of well-developed octahedra and cubes. For the most part, the crystals are less than 0.5 mm in size. Irregular patches of massive cuprite also are present. The majority of crystals are coated with light-green malachite, possibly an alteration product of cuprite. Malachite that is not associated with cuprite occurs in light-to dark-green, acicular and velvety crystal aggregates, and is probably the result of chemical weathering of other copper minerals. Stalactitic and botryoidal forms of goethite generally occur with the cuprite and malachite.

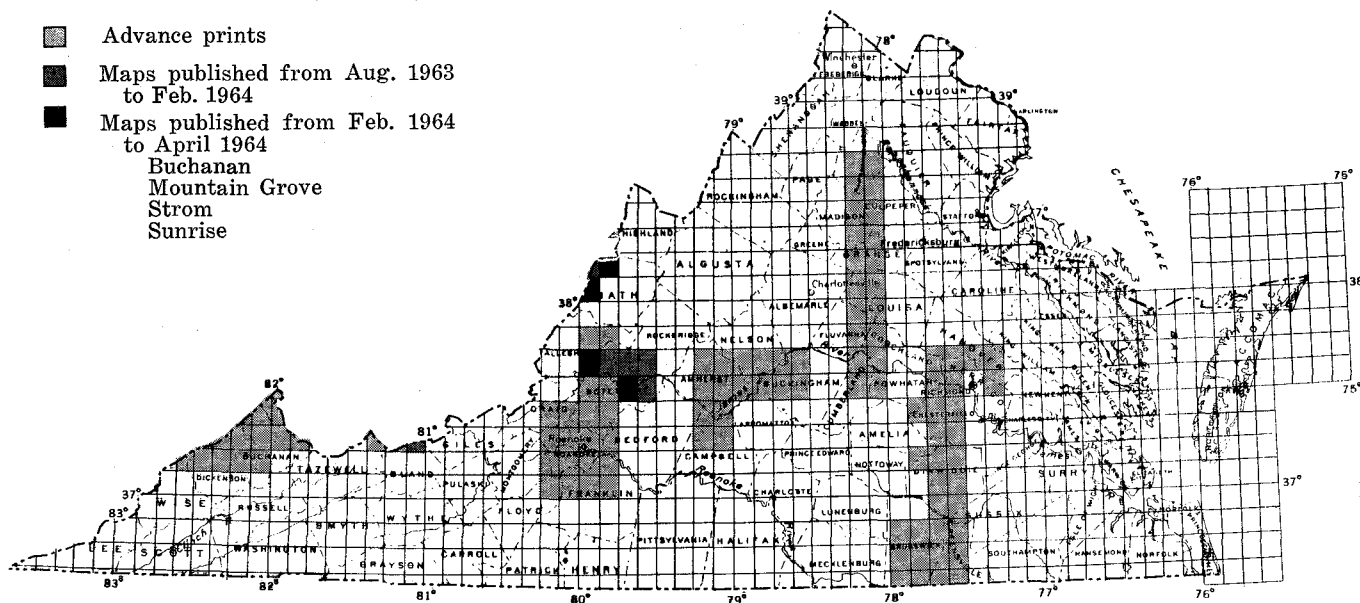
Division of Mineral Resources
Box 3667
Charlottesville, Virginia

Form 3547 Requested

TOPOGRAPHIC MAPS

7.5 minute quadrangle topographic maps

- Advance prints
 - Maps published from Aug. 1963 to Feb. 1964
 - Maps published from Feb. 1964 to April 1964
- Buchanan
Mountain Grove
Strom
Sunrise



ADVANCE PRINTS

Advance prints (blue line) are available at 50 cents each from the U. S. Geological Survey, Topographic Division, 1109 N. Highland St., Arlington, Va.

PUBLISHED MAPS

State index is available free. Published maps are available at 30 cents each from the Virginia Division of Mineral Resources, Box 3667, University Station, Charlottesville, Virginia.